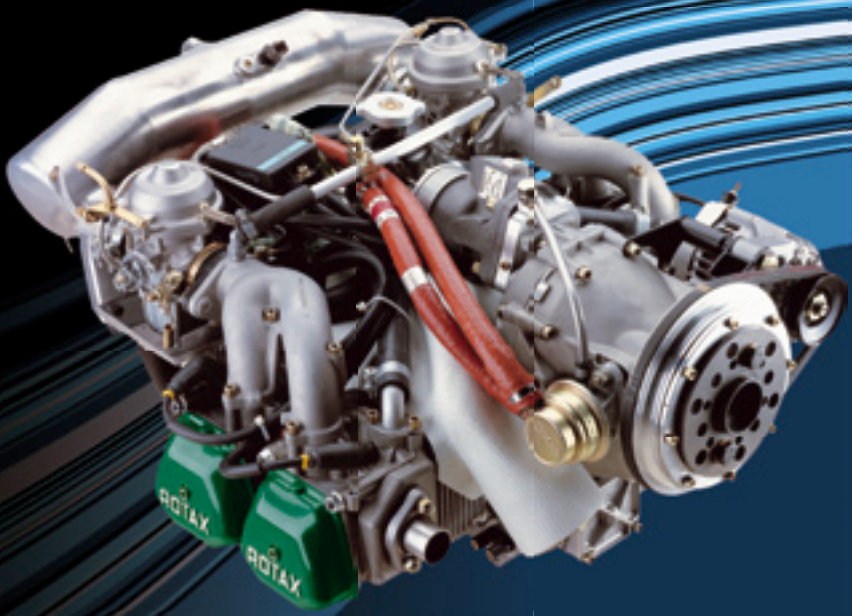
ROTAX
AIRCRAFT ENGINES

OPERATORS MANUAL

FOR ROTAX® ENGINE TYPE 912 SERIES

Ref. No.: OM-912



ROTAX® **912 ULS 3** WITH OPTIONS

part no.: 899371

⚠ WARNING

Before starting the engine, read the Operator´s Manual, as it contains important safety relevant information. Failure to do so may result in personal injuries including death. Consult the original equipment manufacturers handbook for additional instructions!

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Approval of translation has been done to best knowledge and judgement - in any case the original text in german language is authoritative.

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3) Introduction

Congratulations on your decision to purchase a ROTAX aircraft engine.

Before operating the engine, carefully read this Operator's Manual. The Manual provides you with basic information on the safe operation of the engine.

If any passages of the Manual are not clearly understood or in case of any questions, please, contact an authorized Distribution- or Service Center for ROTAX aircraft engines.

We wish you much pleasure and satisfaction flying your aircraft with this ROTAX engine.

3.1) Remarks

The purpose of this Operator's Manual is provided to familiarize the owner/user of this aircraft engine with basic operating instructions and safety information.

For more detailed maintenance, safety and flight information, consult the documentation provided by the aircraft manufacturer and dealer.

For further information on maintenance and spare parts service, contact the nearest ROTAX distribution Center (see Chapter 13).

3.2) Engine serial number

On all enquiries or parts orders, always indicate the engine serial number, as the manufacturer makes modifications to the engine for product improvement. The engine serial number should always be used when ordering parts to ensure correct part selection prior to shipment.

The engine serial number is located on the top of the crankcase, magneto side. See fig. 2.

NOTES

4) Safety

Although the mere reading of these instructions will not eliminate a hazard, the understanding and application of the information herein will promote the proper use of the engine.

The information and components-/system descriptions contained in this Operator's Manual are correct at the time of publication. ROTAX however, maintains a policy of continuous improvement of its products without imposing upon itself any obligation to install them on its products previously manufactured.

ROTAX reserves the right at any time to discontinue or change specifications, designs, features, models or equipment without incurring obligation.

The illustrations in this Manual show the typical construction. They may not represent in full detail or the exact shape of the parts which have the same or similar function.

Specifications are given in the SI metric system with the USA equivalent in parenthesis. Where precise accuracy is not required, some conversions are rounded off for easier use.

This document has been translated from the German language and the original German text shall be deemed authoritative.

4.1) Repeating symbols

This Manual uses the following symbols to emphasize particular information:

▲ **WARNING:**	**Identifies an instruction which, if not followed, may cause serious injury including the possibility of death.**
■ **CAUTION:**	**Denotes an instruction which, if not followed, may severely damage the engine or other component.**
◆ **NOTE:**	**Indicates supplementary information which may be needed to fully complete or understand an instruction.**

4.2) Safety information

▲ WARNING: Never fly the aircraft equipped with this engine at locations, airspeeds, altitudes, or other circumstances from which a successful no-power landing cannot be made, after sudden engine stoppage.

Unless correctly equipped to provide enough electrical power for night VFR (according latest requirement as ASTM), the ROTAX 912 UL/ULS/ULSFR is restricted to DAY VFR only.

- This engine is not suitable for acrobatics (inverted flight, etc.).
- This engine shall not be used on rotorcrafts with an in-flight driven rotor (e.g. helicopters).
- It should be clearly understood that the choice, selection and use of this particular engine on any aircraft is at the sole discretion and responsibility of the aircraft manufacturer, assembler and owner/user.
- Due to the varying designs, equipment and types of aircraft, ROTAX grants no warranty or representation on the suitability of its engine's use on any particular aircraft. Further, ROTAX grants no warranty or representation of this engine's suitability with any other part, component or system which may be selected by the aircraft manufacturer, assembler or user for aircraft application.
- Whether you are a qualified pilot or a novice, complete knowledge of the aircraft, its controls and operation is mandatory before venturing solo. Flying any type of aircraft involves a certain amount of risk. Be informed and prepared for any situation or hazard associated with flying.

  A recognized training program and continued education for piloting an aircraft is absolutely necessary for all aircraft pilots. Make sure you also obtain as much information as possible about your aircraft, its maintenance and operation from your dealer.
- You should be aware that any engine may seize or stall at any time. This could lead to a crash landing and possible severe injury or death. For this reason, we recommend strict compliance with the maintenance and operation and any additional information which may be given to you by your dealer.
- Respect all government or local rules pertaining to flight operation in your flying area. Fly only when and where conditions, topography, and airspeeds are safest.
- Select and use proper aircraft instrumentation. This instrumentation is not included with the ROTAX engine package. Only approved instrumentation may be installed.

- Before flight, ensure that all engine controls are operative. Make sure all controls can be easily reached in case of an emergency.
- Unless in a run up area, never run the engine with the propeller turning while on the ground. Do not operate engine if bystanders are close.
- In the interest of safety, the aircraft must not be left unattended while the engine is running.
- Keep an engine log and respect engine and aircraft maintenance schedules. Keep the engine in top operating condition at all times. Do not operate any aircraft which is not properly maintained or has engine operating irregularities which have not been corrected.

  Since special tools and equipment may be required, engine servicing should only be performed by an authorized ROTAX engine dealer or a qualified trained mechanic approved by the local airworthiness authority.
- To eliminate possible injury or damage, ensure any loose equipment or tools are properly secured before starting the engine.
- When in storage protect the engine and fuel system from contamination and exposure.
- Certain areas, altitudes and conditions present greater risk than others. The engine may require carburetor recalibration or humidity or dust/sand preventative equipment, or additional maintenance may be required.

  Consult your aircraft dealer or manufacturer and obtain the necessary information, especially before flying in new areas.
- Never operate the engine and gearbox without sufficient quantities of lubricating oil.
- Periodically verify level of coolant.
- Never exceed maximum rated r.p.m. Allow the engine to cool at idle for several minutes before turning off the engine.
- This engine may be equipped with an Airborne vacuum pump. The safety warning accompanying the vacuum pump must be given to the owner/ operator of the aircraft into which the vacuum pump is installed.

NOTES

4.3) Technical documentation

These documents form the instructions for continued airworthiness of ROTAX aircraft engines:

- Installation Manual 912 F
- Installation Manual 912 A
- Installation Manual 912 UL
- Installation Manual 912 S
- Operators Manual
- Maintenance Manual 912 Series (Line and Heavy Maintenance)
- Overhaul Manual 912 A / F
- Illustrated Parts Catalog 912 A / F / S / UL / ULS / ULSFR
- Alert Service Bulletins
- Service Bulletins
- Service Instructions
- Service Letters

Any reference to a document refers to the latest edition issued by ROTAX if not stated otherwise.

◆ NOTE: The status of Manuals can be determined by checking the table of amendments of the Manual. The 1st column of this table is the revision status. Compare this number to that listed on the ROTAX WebSite: www.rotax-aircraft-engines.com. Updates and current revisions can be downloaded for free.

The information given in the are based on data and experience that are considered applicable for professionals under normal conditions.

The fast technical progress and variations of installation might render present laws and regulations inapplicable or inadequate.

The illustrations in this Manual are mere sketches and show a typical arrangement. They may not represent the actual part in all its details but depict parts of the same or similar function. Therefore deduction of dimensions or other details from illustrations is not permitted.

All necessary documentation is available from the ROTAX Distribution- and Service Centers (see Chapter 13).

◆ NOTE: The Illustrations in this Operator´s Manual are stored in a graphic data file and are provided with a consecutive irrelevant number.

This number (e.g. *00277*) is of no significance for the content.

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5) Index of pages

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NOTES

6) List of amendments

Approval*

The technical content is approved under the authority

of DOA Nr. EASA.21.J.048.

Currt no.	Chap-ter	Pages	Date of modification	Note of approval	Date of approval by authority	Date of insertion	Marks/ Signa-ture
0	1 to 13	all	01 01 2007	DOA*			
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NOTES

7) Description of design

4-stroke, 4 cylinder horizontally opposed, spark ignition engine, one central camshaft - push-rods - OHV

Liquid cooled cylinder heads

Ram air cooled cylinders

Dry sump forced lubrication

Dual breakerless capacitor discharge ignition

2 constant depression carburetors

mechanical fuel pump

Prop drive via reduction gear with integrated shock absorber and overload clutch

◆ NOTE: The overload clutch is installed on all **serial production** aircraft engines which are certified and on non-certified aircraft engines of the configuration 3.

Electric starter (12V 0,6 kW)

Electric starter (12V 0,9 kW), **optional**

Integrated AC generator with external rectifier-regulator (12V 20A DC)

External alternator (12V 40A DC), **optional**

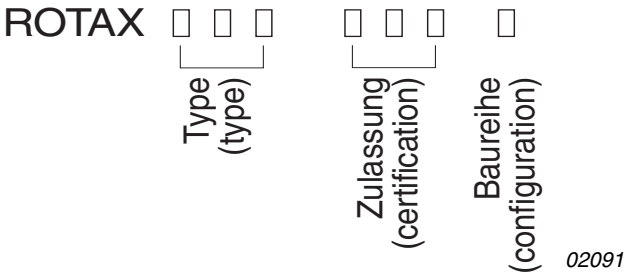
Vacuum pump: (only for A1, A2 and A4 possible), **optional**

Hydraulic constant speed propeller governor: (for A3 only), **optional**

7.1) Type description

e.g. ROTAX 912 A 2

◆ NOTE: The type designation is of the following composition.



Type:	**912**	...	4-cyl. horizontalle opposed, normal aspirated engine
Certification:	**A**	...	certified to JAR 22 (TC No. EASA.E.121)
	F, S	...	certified to FAR 33 (TC No. E00051 EN) JAR-E (TC No. EASA.E.121)
	UL, ULS	...	non-certified aircraft engines
Configuration:	**1**	...	Prop shaft with flange for fixed prop, P.C.D 100 mm

◆ NOTE: This configuration is not available any longer and will be replaced by configuration 2.

2	...	Prop shaft with flange for fixed prop, P.C.D 75 mm, P.C.D 80 mm and 4“ P.C.D
3	...	propeller P.C.D. 75 mm, P.C.D. 80 mm, P.C.D. 4" and drive for hydraulic governor for constant speed propeller
4	...	Prop flange for fixed pitch propeller P.C.D. 75 mm, P.C.D. 80 mm, P.C.D. 4" and prepared for retrofit of a hydraulic governor for constant speed propeller

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7.2) Denomination of cylinders:

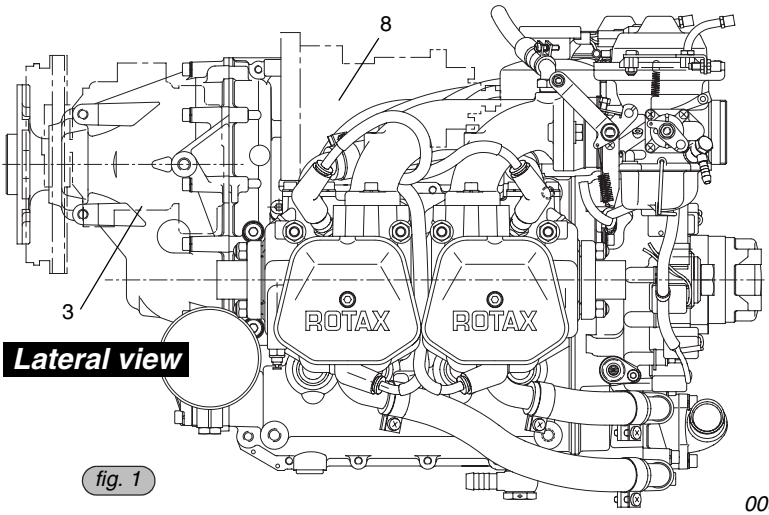

fig. 1

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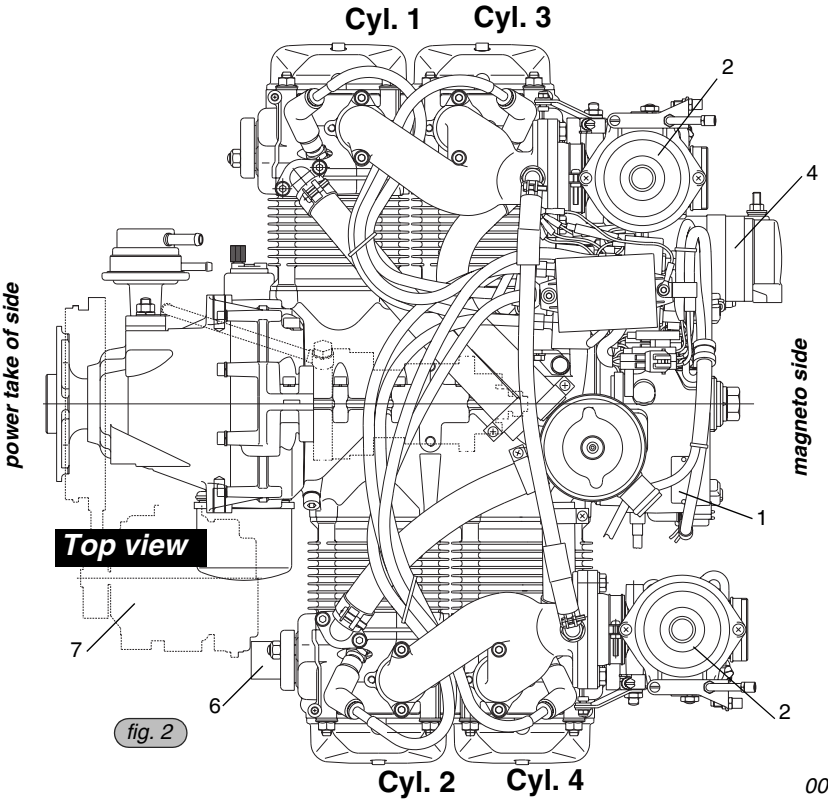

fig. 2

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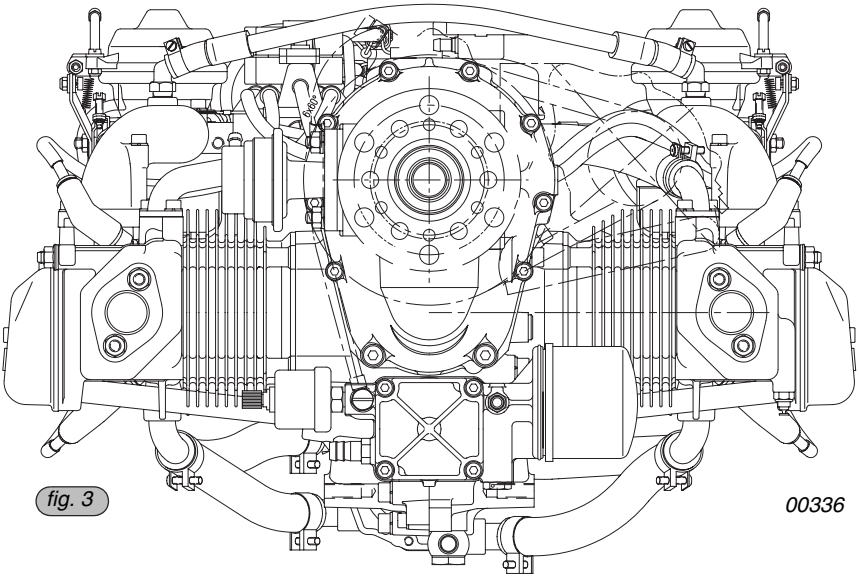

fig. 3 *00336*

Front view

(1) engine serial number
(2) CD carburetor
(3) propeller gear box
(4) electric starter
(5) expansion tank with excess pressure valve
(6) exhaust flange
(7) external alternator
(8) vacuum pump or hydraulic governor for constant speed propeller

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8) Technical data

8.1) Dimensions

Description	912 UL / A / F	912 UL / ULS
Bore	79,5 mm (3,13 in)	84 mm (3,31 in)
Stroke	61 mm (2,40 in)	61 mm (2,40 in)
Displacement	1211 mm^3 (73,9 in^3)	1352 mm^3 (82,5 in^3)
Compression ratio.	9,0 : 1	10,5 : 1

8.2) Weights

◆ NOTE: The stated weights are dry weights (without operating fluids)

with: electric starter, carburetors, internal generator, ignition unit and oil tank

without: exhaust system, radiator, airbox

Weight in kg (lb)	912 UL	912 A	912 F	912 ULS	912 S
Configuration 2/4	57,1 (126) with overload clutch	57,1 (126)	57,1 (126)	58,3 (128) with overload clutch	58,3 (128)
	55,4 (122) without clutch			56,6 (125) without clutch	
Configuration 3	59,8 (132)			61 (134)	

Equipment:

External alternator: ..... 3,0 kg (6,6 lb)

Vacuum pump: ..... 0,8 kg (1,8 lb)

Overload clutch: ..... 1,7 kg (3,7 lb)

◆ NOTE: The overload clutch is installed on all certified aircraft engines and on non-certified aircraft engines of the configuration 3.

8.3) Fuel consumption

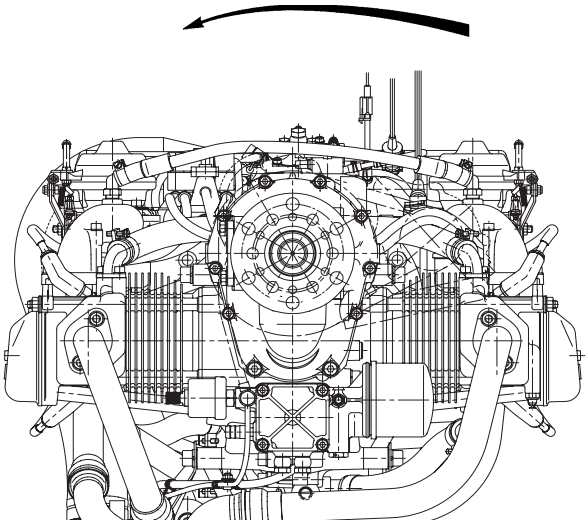
Fuel consumption in l/h (US gal/h)	912 UL / A F	912 ULS / S
at take-off performance	24,0 (6,3)	27,0 (7,1)
at max. continuous performance	22,6 (5,6)	25,0 (6,6)
at 75% ontinuous performance	16,2 (4,3)	18,5 (4,9)
specific consumtion at max. continuous performance	285 g/kWh (0,47 lb/hph)	285 g/kWh (0,47 lb/hph)

8.4) Direction of rotation

Direction of rotation on propeller shaft: ..... counter clockwise, looking at p.t.o. side of engine

◆ NOTE: Propeller shouldn't be turned reverse the normal direction of engine rotation.

normal direction of propeller rotation (engine)



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9) Description of systems

9.1) Cooling system

See fig. 4.

The cooling system of the ROTAX 912 is designed for liquid cooling of the cylinder heads and ram-air cooling of the cylinders. The cooling system of the cylinder heads is a closed circuit with an expansion tank.

The coolant flow is forced by a water pump, driven from the camshaft, from the radiator to the cylinder heads. From the top of the cylinder heads the coolant passes on to the expansion tank (**1**). Since the standard location of the radiator (**2**) is below engine level, the expansion tank located on top of the engine allows for coolant expansion.

The expansion tank is closed by a pressure cap (**3**) (with excess pressure valve and return valve). At temperature rise of the coolant the excess pressure valve opens and the coolant will flow via a hose at atmospheric pressure to the transparent overflow bottle (**4**). When cooling down, the coolant will be sucked back into the cooling circuit.

◆ NOTE: Coolant temperatures are measured by means of temperature probes installed in cylinder heads 2 and 3.

Readings are taken on measuring point of the hottest cylinder head, depending on engine installation.

Coolant, see Chapter 10.2.1).

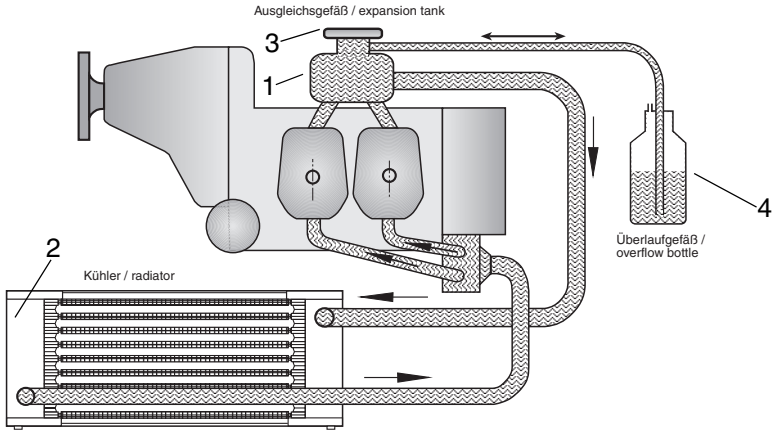

fig. 4
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9.2) Fuel system

See fig. 5.

The fuel flows from the tank (**1**) via a coarse filter (**2**) the safety cock (**3**), water drain cock (**4**) and fine filter (**5**) to the mechanical fuel pump (**6**). From the pump fuel passes on to the two carburetors (**7**).

Via the return line (**8**) surplus fuel flows back to the fuel tank.

◆ NOTE: The return line serves to avoid formation of vapour lock.

Fuel, see Chapter 10.2.2).

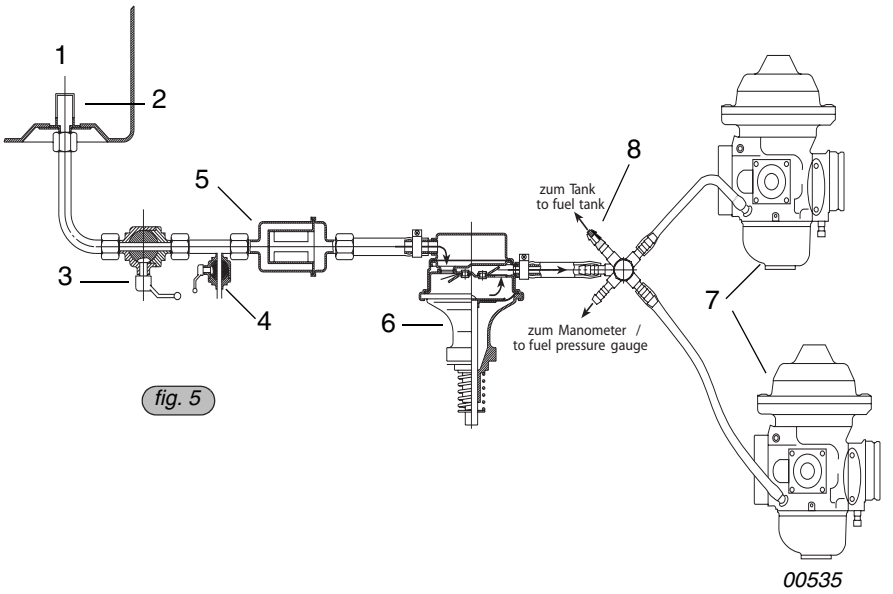

fig. 5

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9.3) Lubrication system

See fig. 6.

The ROTAX 912 engine is provided with a dry sump forced lubrication system with a main oil pump with integrated pressure regulator (**1**) and oil pressure sensor (**2**).

◆ NOTE: The oil pump is driven by the camshaft.

The oil pump (**3**) sucks the motor oil from the oil tank (**4**) via the oil cooler (**5**) and forces it through the oil filter (**6**) to the points of lubrication in the engine.

The surplus oil emerging from the points of lubrication accumulates on the bottom of crankcase and is forced back to the oil tank by the blow-by gases.

◆ NOTE: The oil circuit is vented via bore (**7**) on the oil tank.

◆ NOTE: The oil temperature sensor (**8**) for reading of the oil inlet temperature is located on the oil pump housing.

Lubricants, see Chapter 10.2.3).

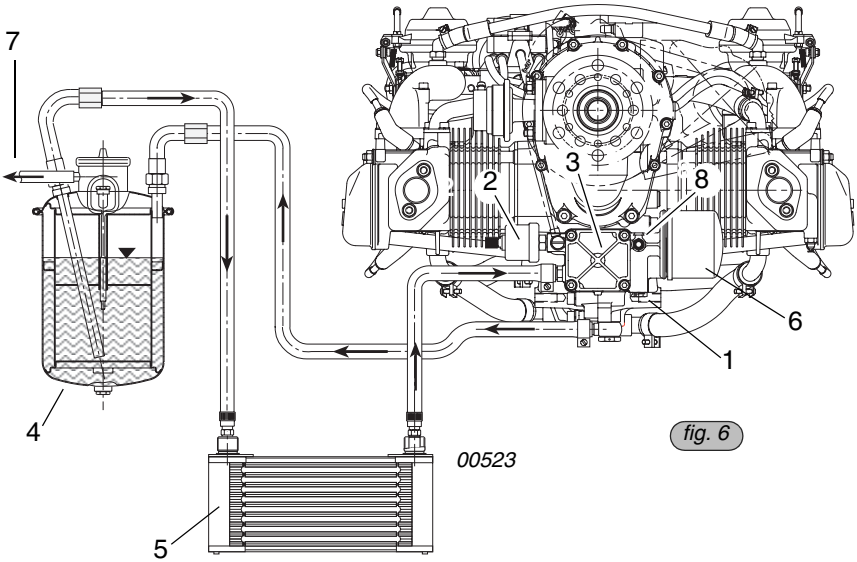


fig. 6

d03933.fm

9.4) Electric system

See fig. 7.

The ROTAX 912 engine is equipped with a dual ignition unit of a breakerless, capacitor discharge design, with an integrated generator.

The ignition unit is completely free of maintenance and needs no external power supply.

Two independent charging coils (**1**) located on the generator stator supply one ignition circuit each. The energy is stored in capacitors of the electronic modules (**2**). At the moment of ignition 2 each of the 4 external trigger coils (**3**) actuate the discharge of the capacitors via the primary circuit of the dual ignition coils (**4**).

Firing order: 1-4-2-3.

◆ NOTE: The 5th trigger coil (**5**) is planned for rev. counter signal.

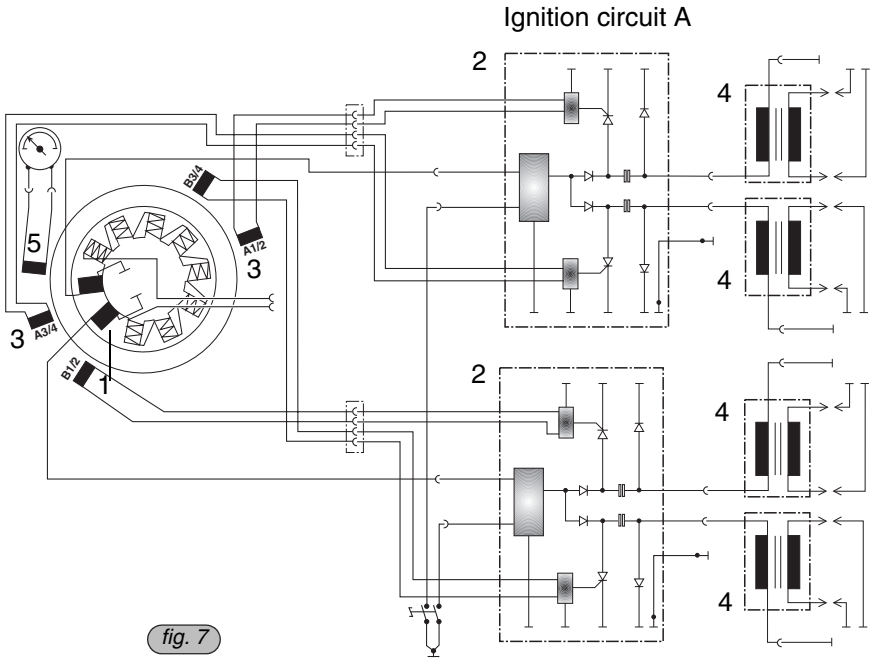


fig. 7

d03933.fm

9.5) Propeller gearbox

See fig. 8.

For the engine type 912 two reduction ratios are available.

reduction ratio	912 UL / A / F	912 ULS / S
crankshaft: propeller shaft	2,27 : 1	2,43 : 1
	2,43 : 1 (optional)	

Depending on engine type, certification and configuration the propeller gearbox is supplied with or without an overload clutch.

◆ NOTE: The overload clutch is installed on serial production on all certified aircraft engines and on the non-certified aircraft engines of configuration 3.

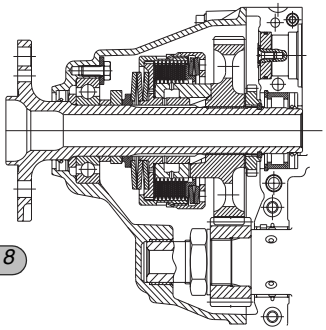


fig. 8

02531

◆ NOTE: Fig. 8 shows a propeller gearbox of configuration 2 with the integrated overload clutch.

The design incorporates a torsional shock absorber. The shock absorbing is based on progressive torsional cushioning due to axial spring load acting on a dog hub.

On the gearbox version with overload clutch the design incorporates a friction damped free play at the dogs to warrant proper engine idling.

Due to this backlash at the dogs a distinct torsional impact arises at start, stop and at sudden load changes, but due to the built-in overload clutch it will remain harmless.

◆ NOTE: This overload clutch will also prevent any undue load to the crankshaft in case of ground contact of the propeller.

Alternatively **either** a vacuum pump **or** a hydraulic governor for constant speed propeller can be used. The drive is in each case via the propeller reduction gear.

9.5.1) Hydr. governor for const. speed propeller, vacuum pump:

Alternatively **either** a vacuum pump **or** a hydraulic governor for constant speed propeller can be used. The drive is in each case via the propeller reduction gear.

Gear ratio:

gear ratio		
crankshaft : propeller shaft	2,27 : 1	2,43 : 1
propeller shaft : hydraulic governor/vacuum pump	0,758 : 1	
crankshaft : hydraulic governor/vacuum pump	1,724 : 1	1,842 : 1

◆ NOTE: Transmission ratio between crankshaft and hydraulic governor or vacuum pump is either 1,842 or 1,724 i.e. the speed of the hydraulic governor or vacuum pump is either 0,54 or 0,58 of engine speed.

d03933.fm

10) Operating instructions

The data of the certified engines are based on type certificate of type
912 A JAR 22 (TC No. EASA.E.121),
912 F / S FAR 33 (TC No. E00051EN), JAR-E (TC No. EASA.E.121)

10.1) General limits of operation

10.1.1) Operating speeds and limits (912 UL / A / F)

1. **Speed:**
   Take-off speed ..... 5800 1/min (5 min.)
   Max. continuous speed 5500 1/min
   Idle speed ..... approx. 1400 1/min
2. **Performance (ISA):** (**I**nternational **S**tandard **A**tmosphere)
   Take-off performance ..... 59,6 kW at 5800 1/min
   Max. continuous performance ..... 58 kW at 5500 1/min
3. **Acceleration:**
   Limit of engine operation at zero gravity and in **negative "g"** condition
   max. ..... 5 seconds at max. -0,5 g
4. **Oil pressure:**
   max. ..... 7 bar

   ■ CAUTION: For a short period admissible at cold start.

   min. ..... 0,8 bar (12 psi) (below 3500 rpm)
   normal ..... 2,0 - 5,0 bar (29 - 73 psi) (above
   ..... 3500 rpm)
5. **Oil temperature:**
   max. ..... 140 °C .....(285 °F)
   min. ..... 50 °C .....(120 °F)
   normal operating temperature ..... approx.. 90 - 110 °C (190 - 230 °F)
6. **Coolant**
   See Operating media Chapter 10.2.1
   - In use of conventional coolant:

     Coolant temperature: (coolant exit temperature)

     max.....120 °C (248 °F)

     Cylinder head temperature:

     max.....150 °C (300 °F)

     Permanent monitoring of coolant temperature and cylinder head temperature is necessary.
   - In use of waterless coolant:

     Cylinder head temperature:

     max.....150 °C (300 °F)

     Permanent monitoring of cylinder head temperature is necessary.

7. **Engine start, operating temperature:**
   max. ..... 50 °C ..... (120 °F)
   min. ..... -25 °C ..... (-13 °F)

8. **Fuel pressure:**
   max. ..... 0,4 bar ..... 5,8 psi)
   min. ..... 0,15 bar ..... 2,2 psi)

   ▲ WARNING: Exceeding the max. admissible fuel pressure will override the float valve of the carburetor and to engine failure.

The aircraft engine manufacturer strongly recommends the installation of an additional pump, unless this has not been covered by legal obligations so far.

9. **Power consumption of the hydraulic propeller governor:**
   max. ..... 600 W

10. **Power consumption of the vacuum pump:**
    max. ..... 300 W

11. **Power consumption of the external alternator:**
    max. ..... 1200 W

12. **Deviation from bank angle**
    max. ..... 40°

    ◆ NOTE: Up to this value the dry sump lubrication system warrants lubrication in every flight situation.

10.1.1.1) Performance graphs for stand. conditions (ISA)

00450

A: max. engine output
B: power requirement of propeller

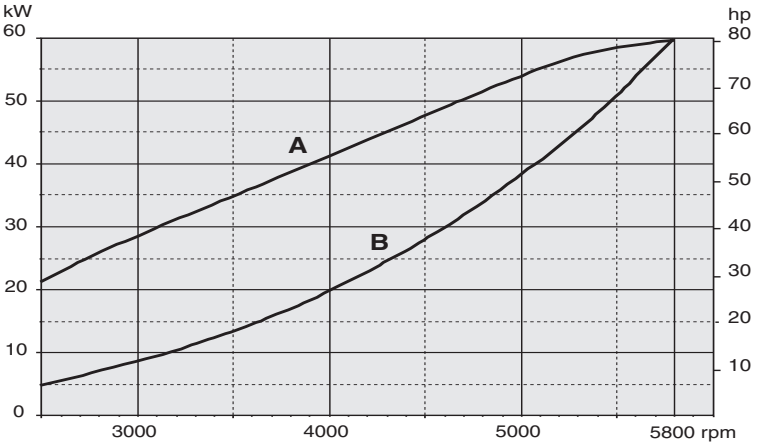
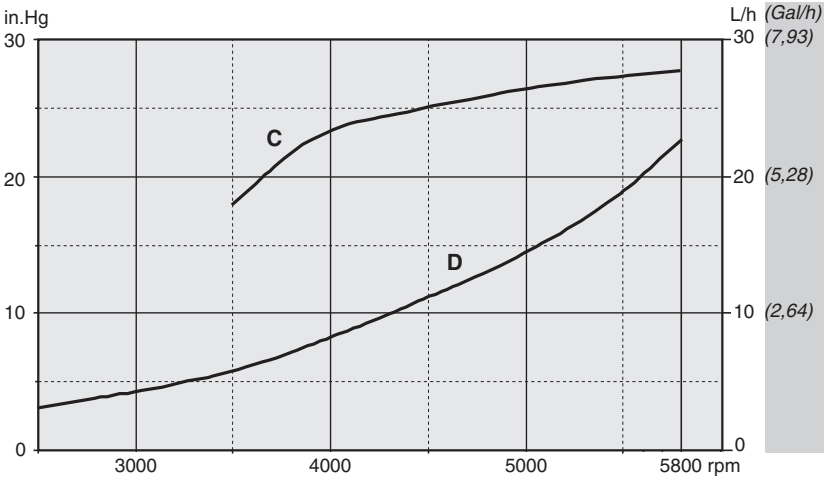


fig. 9

00451

C: manifold pressure
D: fuel consumption



Values along propeller curve

fig. 10

d03934.fm

Performance data for variable pitch propeller:

Engine operation is permitted without restriction between full throttle performance and power requirement of propeller, providing engine speed over 5500 r.p.m. is restricted to 5 minutes.

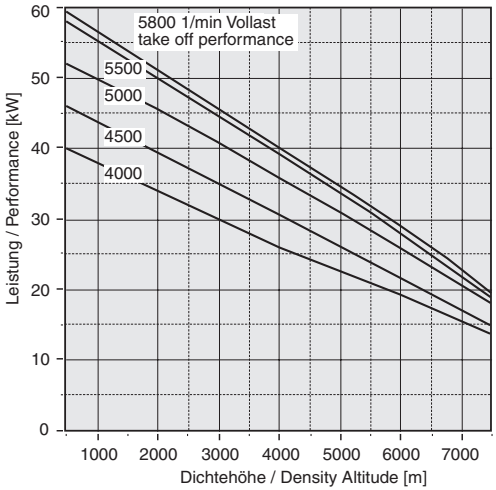
However, for economic reasons it is recommended to run the engine in accordance with the following table:

Engine Power-Setting	Engine speed [rpm]	Performance [kW]	Torque [Nm]	Manifold pres. [in.HG]
Take-off perform.	5800	59,6	98,1	full throttle
cruising power	5500	58,0	100,7	full throttle
75%	5000	43,5	83,1	27,2
65%	4800	37,7	75,0	26,5
55%	4300	31,9	70,8	26,3

10.1.1.2) Performance graph for non-standard conditions

The following graph shows the performance drop with increasing flight altitude. The curves show the performance at 5800, 5500, 5000, 4500 and 4000 r.p.m., at full throttle.

The engine allows operation with fully open throttle valve over the whole r.p.m. range, without limitation. But full throttle performance above 5500 r.p.m. is limited to 5 minutes.



00452

fig. 11

At deviation of temperature conditions from standard atmosphere conditions the engine performance to be expected can be calculated from the performance indicated, multiplied by standard temperature, divided by actual temperature in °K.

$$P_{akt.} = P_{stand.} \frac{T_{standard}}{T_{aktuell}}$$

T[K] = t [°C]+273

d03934.fm

10.1.2) Operating speeds and limits (912 ULS / S)

1. **Speed:**
   Take-off speed ..... 5800 1/min (5 min.)
   Max. continuous speed 5500 1/min
   Idle speed ..... approx. 1400 1/min

2. **Performance (ISA):** (**I**nternational **S**tandard **A**tmosphere)
   Take-off performance..... 73,5 kW at 5800 1/min
   Max. continuous performance..... 69 kW at 5500 1/min

3. **Acceleration:**
   Limit of engine operation at zero gravity and in **negative "g"** conditions

   max. ..... 5 seconds at max. -0,5 g

4. **Oil pressure:**
   max. ..... 7 bar

   ■ CAUTION: For a short period admissible at cold start.

   min. ..... 0,8 bar (12 psi) (below 3500 rpm)
   normal ..... 2,0 - 5,0 bar (29 - 73 psi) (above 3500 rpm)

5. **Oil temperature:**
   max. ..... 130 °C.....(266 °F)
   min. ..... 50 °C.....(120 °F)
   normal operating temperature..... approx. 90 - 110 °C (190 - 230 °F)

6. **Coolant:**
   See Operating media Chapter 10.2.1

   - In use of conventional coolant:

     Coolant temperature: (coolant exit temperature)
     max.....120 °C (248 °F)

     Cylinder head temperature:
     max.....135 °C (275 °F)

     Permanent monitoring of coolant temperature and cylinder head temperature is necessary.

   - In use of waterless coolant:

     Cylinder head temperature:
     max.....135 °C (275 °F)

     Permanent monitoring of cylinder head temperature is necessary.

7. **Engine start, operating temperature:**
   max. ..... 50 °C.....(120 °F)
   min. ..... - 25 °C .....(- 13 °F)

8. Fuel pressure:

max.....0,4 bar ..... (5,8 psi)
min.....0,15 bar ..... (2,2 psi)

▲ WARNING: Exceeding the max. admissible fuel pressure will override the float valve of the carburetor and to engine failure.

The aircraft engine manufacturer strongly recommends the installation of an additional pump, unless this has not been covered by legal obligations so far.

9. Power consumption of the hydraulic propeller governor:

max.....600 W

10. Power consumption of the vacuum pump:

max.....300 W

11. Power consumption of the external alternator:

max.....1200 W

12. Deviation from bank angle

max.....40°

◆ NOTE: Up to this value the dry sump lubrication system warrants lubrication in every flight situation.

10.1.2.1) Performance graphs for stand. conditions (ISA)

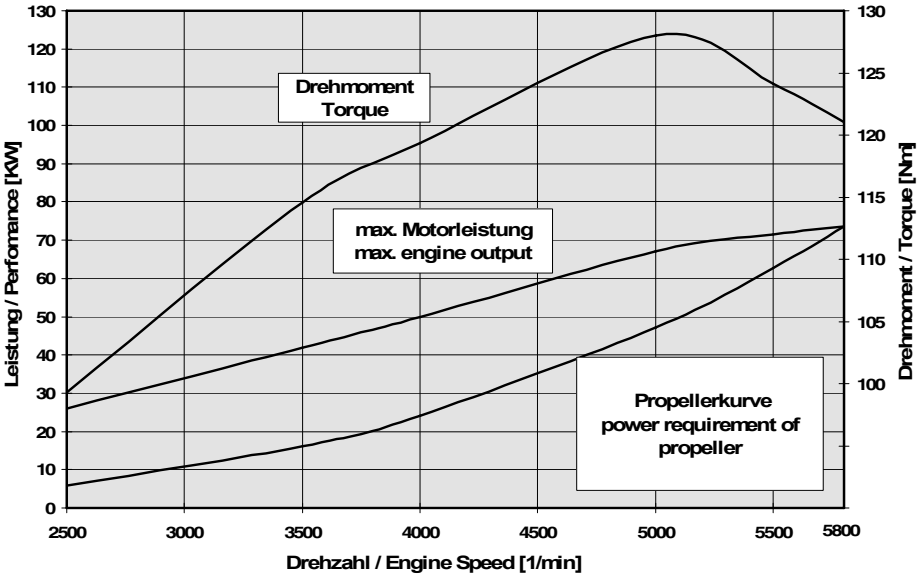


fig. 12

02001

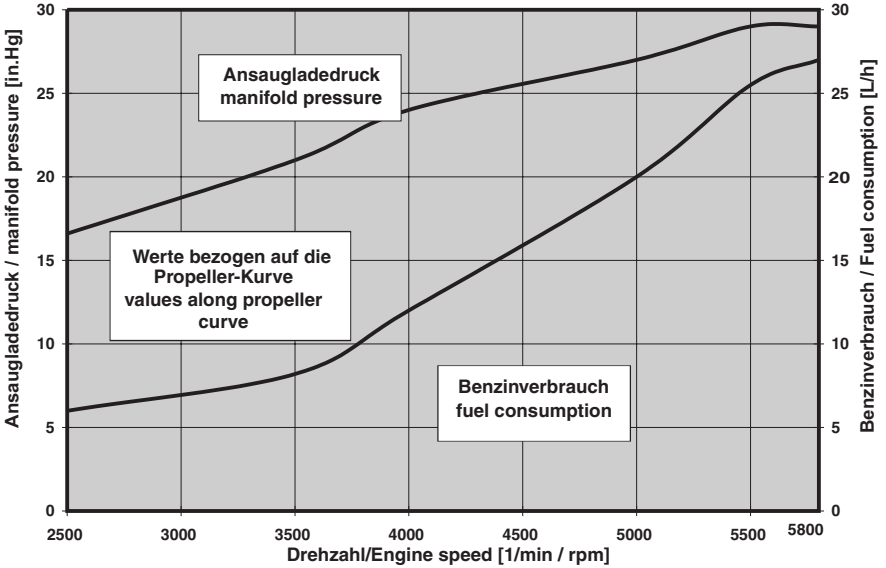


fig. 13

02002

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Performance data for variable pitch propeller:

Engine operation is permitted without restriction between full throttle performance and power requirement of propeller, providing engine speed over 5500 r.p.m. is restricted to 5 minutes.

However, for economic reasons it is recommended to run the engine in accordance with the following table:

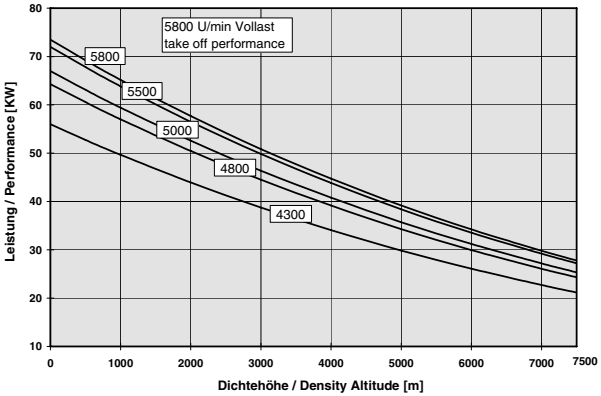
Engine Power-Setting	Engine speed [rpm]	Performance [kW]	Torque [Nm]	Manifold pres. [in.HG]
Take-off perform.	5800	73,5	121,0	27,5
cruising power	5500	69,0	119,8	27
75%	5000	51,0	97,4	26
65%	4800	44,6	88,7	26
55%	4300	38,0	84,3	24

10.1.2.2) Performance graph for non-standard conditions

The following graph shows the performance drop with increasing flight altitude. The curves show the performance at 5800, 5500, 5000, 4800 and 4300 r.p.m., at full throttle.

The engine allows operation with fully open throttle valve over the whole r.p.m. range, without limitation. But full throttle performance above 5500 r.p.m. is limited to 5 minutes.

At deviation of temperature conditions from standard atmosphere conditions the engine performance to be expected can be calculated from the performance indicated, multiplied by standard temperature, divided by actual temperature in °K.



$$P_{akt.} = P_{stand.} \frac{T_{standard}}{T_{aktuell}}$$

T[K] = t [°C]+273

fig. 14

05482

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10.2) Operating media

10.2.1) Coolant

In principle, 2 different types of coolant are permitted.

- Conventional coolant based on ethylene glycol
- Waterless coolant based on propylene glycol

■ CAUTION: Obey the manufacturer's instructions about the coolant.

	mixture ratio %	
designation	**concentrate**	**water**
conventional e.g. BASF Glysantine anticorrosion	50	50
waterless e.g. EVANS NPG+	100	0

Conventional coolant mixed with water has the advantage of a higher specific thermal capacity than water-less coolant.

◆ NOTE: The important advantage of water-less coolant is its higher boiling point than a conventional mixture.

When correctly applied, there is sufficient protection against vapor bubble formation, freezing or thickening of the coolant within the operating limits.

Use the coolant specified in the manufacturer's documentation.

■ CAUTION: Obey the latest edition of Service Instruction SI-912-016 for the selection of the correct coolant.

10.2.2) Fuel

The following fuels can be used :

	Usage / Description	
	912 UL / A / F	**912 ULS / S**
MOGAS		
European standard	EN 228 Normal [1)]	
	EN 228 Super [1)]	EN 228 Super [2)]
	EN 228 Super plus [1)]	EN 228 Super plus [2)]
Canadian standard	CAN/CGSB3.5 Quality 1 [3)]	CAN/CGSB3.5 Quality 3 [4)]
US standard	ASTM D4814	ASTM D4814

AVGAS		
US standard	AVGAS 100 LL (ASTM D910)	AVGAS 100 LL (ASTM D910)

[1)] min. ROZ 90

[2)] min. ROZ 95

[3)] min. AKI* 87

[4)] min. AKI 91

AVGAS 100LL places greater stress on the valve seats due to its high lead content and forms increased deposits in the combustion chamber and lead sediments in the oil system. Thus it should only be used in case of problems with vapor lock or when other types of gasoline are unavailable.

■ CAUTION: Use only fuel suitable for the respective climatic zone.

◆ NOTE: Risk of vapour formation if using winter fuel for summer operation.

■ CAUTION: Obey the latest edition of Service Instruction SI-912-016 for the selection of the correct fuel.

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10.2.3) Lubricants

Oil: Motorcycle oil of a registered brand with gear additives. If using aircraft engine oil; than only blended one.

■ CAUTION: At the selection of suitable lubricants refer to the additional information in the Service Information SI-912-016, latest edition.

Oil specification

- Use only oil with API classification **"SG"** or higher!
- Due to the high stresses in the reduction gears, oils with gear additives such as high performance motor cycle oils are required.
- Because of the incorporated friction clutch, oils with friction modifier additives are unsuitable as this could result in a slipping clutch during normal operation.
- Heavy dury 4-stroke motor cycle oils meet all the requirements. These oils are normally no mineral oils but semi- or full synthetic oils.
- Oils primarity for Diesel engines are due to **insufficient high temperature properties and additives which favour clutch slipping, generally unsuitable.**

■ CAUTION: If the engine is mainly run on AVGAS **more frequent** oil changes will be required. See Service Information SI-912-016, latest edition.

Oil consumption: ..... max 0,06 l/h (0.13 liq pt/h)

Oil viscosity:

Use of multi-grade oils is recommended.

◆ NOTE: Multi-viscosity grade oils are less sensitive to temperature variations than single grade oils. They are suitable for use throughout the seasons, ensure rapid lubrication of all engine components at cold start and get less fluid at higher temperatures.

Table of lubricants (See fig. 15)

Since the temperature range of neighboring SAE grades overlap, there is no need for change of oil viscosity at short duration of ambient temperature fluctuations.

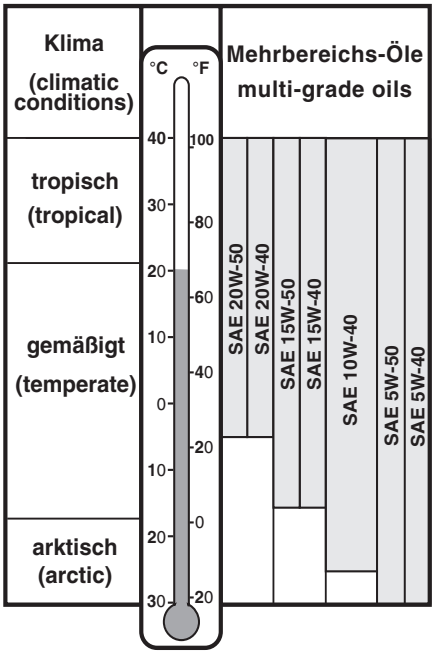

fig. 15 *01176*

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10.3) Standard operation

To warrant reliability and efficiency of the engine, meet and carefully observe all the operating and maintenance instructions.

10.3.1) Daily checks

▲ WARNING: **Risk of burnings and scalds!**
Conduct checks on the cold engine only!

▲ WARNING: **Ignition "OFF".** Before cranking the propeller switch off both ignition circuits and anchor the aircraft. Have the cockpit occupied by a competent person.

■ CAUTION: If established abnormalities (e.g. excessive resistance of the engine, noises etc.) inspection in accordance with the relevant Maintenance Manual is necessary. Do not release the engine into service before rectification.

Coolant level:

■ CAUTION: The coolant specifications of the section 10.2) Operating media are to be observed.

- Verify coolant level in the **expansion tank**, replenish as required up to top.

  The coolant level must be at least 2/3 of the expansion tank.

- Verify coolant level in the **overflow bottle**, replenish as required.

  The coolant level must be between max. and min. mark or at least 0.2 litre (0.4 liq pt).

Check of mechanical components:

Turn propeller by hand in direction of engine rotation several times and observe engine for odd noises or excessive resistance and normal compression.

Gear box:

- **Version without overload clutch:**

  No further checks are necessary.

- **Version with overload clutch:**

  Turn the propeller by hand to and fro, feeling the free rotation of 15° or 30° before the crankshaft starts to rotate.

  If the propeller can be turned between the dogs with practically **no friction** at all (less than 25 Nm = 222 in.lb) further investigation is necessary.

Carburetor:

- Verify free movement of throttle cable and starting carburetor over the complete range. Check from the cockpit.

Exhaust system:

- Inspect for damages, leakage and general condition.

10.3.2) Before engine start

Carry out pre-flight checks.

10.3.3) Pre-flight checks

▲ WARNING: **Ignition "OFF"** Before cranking the propeller switch off both ignition circuits and anchor the aircraft. Have the cockpit occupied by a competent person.

Operating media:

▲ WARNING: Carry out pre-flight checks on the cold or luke warm engine only! **Risk of burning and scalds.**

Check for any oil-, coolant- and fuel leaks.

If leaks are evident, rectify before flight.

■ CAUTION: The coolant specifications of the section 10.2) Operating media are to be observed.

- Verify coolant level in the **overflow bottle**, replenish as required up to top.

  The coolant level must be between min. and max. mark or at least 0.2 litre (0.4 liq pt).

■ CAUTION: The oil specifications of the section 10.2) Operating media are to be observed.

- Check oil level and replenish as required.

◆ NOTE: Propeller shouldn't be turned reverse the normal direction of engine rotation.

- Prior to oil check, turn the propeller by hand in direction of engine rotation several times to pump oil from the engine into the oil tank, or let the engine idle for 1 minute.

  It is essential to build up compression in the combustion chamber. Maintain the pressure for a few seconds to let the gas flow via the piston rings into the crankcase. The speed of rotation is not important as the pressure and the amount of gas which is transfered into the crankcase.

  This process is finished when air is returning back to the oil tank and can be noticed by a murmur from the open oil tank.

◆ NOTE: The oil level should be in the upper half (between the “50%“ and the “max“ mark) and should never falls below the “min“ mark. Prior to long flights oil should be added so that the oil level reaches the “max“ mark.

Avoid oil levels exceeding the “max“ mark, since excess oil could be poured out through the venting system.

Difference between max.- and min.- mark = 0,45 litre (0.95 liq pt)

10.3.4) Engine start

▲ WARNING: Do not take the engine into operation if any person is near the aircraft.

Fuel cock...... open

Starting carb. ..... activated

◆ NOTE: If the engine is already in operating temperature, start the engine without choke.

Throttle lever. ..... set to idle position

Master switch. ..... on

Ignition. ..... both circuits switched on

Starter button. ..... actuate

■ CAUTION: Activate starter for max. 10 sec. only (without interruption), followed by a cooling period of 2 minutes!

As soon as engine runs, adjust throttle to achieve smooth running at approx. 2500 r.p.m.

Check if oil pressure has risen within 10 seconds and monitor oil pressure. Increase of engine speed is only permitted at steady oil pressure readings above 2 bar (30 psi).

At an engine start with low oil temperature, continue to observe the oil pressure as it could drop again due to the increased flow resistance in the suction line. The number of revolutions may be only so far increased that the oil pressure remains steady.

De-activate starting carb.

■ CAUTION: Since the engine comprises a reduction gear with shock absorber, take special care of the following:

To prevent impact load, start with throttle lever in idle position or at the most up to 10% open. For the same reason, wait for around 3 sec. after throttling back to partial load to reach constant speed before re-acceleration.

For checking the two ignition circuits, only one circuit may be switched off and on at times.

■ CAUTION: Do not actuate starter button (switch) as long as the engine is running. Wait until complete stop of engine!

10.3.5) Prior to take-off

Warming up period:

Start warming up period at 2000 r.p.m. for approx. 2 minutes, continue at 2500 r.p.m., duration depending on ambient temperature, until oil temperature reaches 50 °C (120 °F).

- Check temperatures and pressures.

Throttle response:

- Short full throttle ground test (consult Aircraft Operator's Manual since engine speed depends on the propeller used).

■ CAUTION: After a full-load ground test allow a short cooling run to prevent vapour formation in the cylinder head.

Ignition check:

Check the two ignition circuits at **4000 r.p.m.** (approx. 1700 r.p.m. propeller).

- Speed drop with only one ignition circuit must not exceed **300 r.p.m.** (approx. 130 r.p.m. propeller).

- **115 r.p.m.** (approx. 50 r.p.m. propeller) max. difference of speed by use of either circuit, A or B.

◆ NOTE: The propeller speed depends on the actual reduction ratio.

Check of hydraulic propeller governor:

Check control of the hydraulic propeller governor to specifications of the manufacturer.

10.3.6) Take-off

Climbing with engine running at take-off performance is permissible (max. 5 minutes). See Chapter 10.1), 10.1.1) and 10.1.2).

▲ WARNING: Monitor oil temperature, cylinder head temperature and oil pressure. Limits must not be exceeded! See Chapter 10.1) Operating Limits.

■ CAUTION: Respect "cold weather operation" recommendations, see Chapter 10.3.9).

10.3.7) Cruising

Set performance as per performance specifications and respect operating limits as per Chapter 10.1), 10.1.1) and 10.1.2).

Avoid operation below normal operation oil temperature (90 - 110 °C / 194 - 230 °F), as possible formation of condensation water in the lubrication system badly influences the oil quality.

To evaporate possibly accumulated condensation water, at least once a day 100 °C (212 °F) oil temperature must be reached.

10.3.8) Engine shut-off

Normally the cooling down of the engine during descending and taxiing will be sufficient to allow the engine to be shut off as soon as the aircraft is stopped.

At increased operating temperatures to make an engine cooling run of at minimum 2 minutes.

10.3.9) Cold weather operation

Generally, an engine service should be carried out before the start of the cold season.

Coolant:

For selection of coolant and mixing ratio, see "Coolant", Chapter 10.2.1).

Lubricant:

For selection of oil, see Table of Lubricants (Chapter 10.2.3).

Cold start:

- With throttle closed and choke activated (open throttle renders starting carb ineffective).
- Be aware, no spark below crankshaft speed of 220 rpm. (propeller speed of 90 rpm.).
- As performance of electric starter is greatly reduced when hot, limit starting to periods not much longer than 10 sec. With a well charged battery, adding a second battery will not improve cold starts.

Remedy:

- Use of multigrade oil with the low end viscosity code of 5 or 10.
- Gap electrode on spark plug to the minimum or fit new spark plugs.

- Preheat engine using hot air.

Beyond that observe following advices for operation at extremely low temperatures:

◆ NOTE: Distinguish between two kinds of carb icing:

1) Icing due to water in fuel

2) Icing because of high air humidity

Addendum to note 1)

Water in fuel will accumulate at the lower parts of the fuel system and leads to freezing of fuel lines, filters or jets.

Remedy:

- Use non-contaminated fuel (filtered through suède)
- Generously sized water separators
- Fuel lines routing inclined
- Prevent condensation of humidity, i.e. avoid temperature differences between aircraft and fuel.

▲ WARNING: Fuels containing alcohol always carry a small amount of water in solution. In case of temperature changes or increase of alcohol content, water or a mixture of alcohol and water may settle and could cause troubles.

Addendum to note 2)

Carburetor icing due to humidity may occur on the venturi and on the throttle valve due to fuel evaporation and leads to performance loss and change in mixture. Intake air pre-heating is the only effective remedy.

10.4) Abnormal operation

▲ **WARNING:** **At unusual engine behaviour conduct checks as per Chapter 10.4.1) through 10.4.13) below, and as per Maintenance Manual, Chapter 05) before the next flight.**

◆ NOTE: Further checks - see Maintenance Manual.

10.4.1) Engine stop - Start during flight

Starting procedure same as on ground, however, on a warm engine without choke.

10.4.2) Exceeding of max. admissible engine speed

Reduce engine speed. Any exceeding of the max. admissible engine speed has to be entered by the pilot into the logbook, stating duration and extent of overspeed.

10.4.3) Exceeding of max. admissible cyl. head temperature

▲ WARNING: Reduce engine power setting to the minimum necessary and carry out precautionary landing.

Any exceeding of the max. admissible cylinder head temperature has to be entered by the pilot into the logbook, stating duration and extent of over-temperature condition.

10.4.4) Exceeding of max. admissible oil temperature

▲ WARNING: Reduce engine power setting to the minimum necessary and carry out precautionary landing.

Any exceeding of the max. oil temperature must be entered by the pilot in the logbook, stating duration and extent of over-temperature condition.

10.4.5) Oil pressure below minimum - during flight

▲ WARNING: Reduce engine power setting to the minimum necessary and carry out precautionary landing.

Check oil system.

10.4.6) Oil pressure below minimum - on ground

Immediately stop the engine and check for reason. Check oil system.

- Check oil quantity in oil tank.
- Check oil quality (see section 10.2.3).

11) Checks

All checks to be carried out as specified in the current Maintenance Manual (last revision).

▲ **WARNING:** **Only qualified staff (authorized by the Aviation Authorities) trained on this particular engine, is allowed to carry out maintenance and repair work.**

■ CAUTION: Carry out all directives of Service Bulletins (SB), according to their **priority.**

11.1) Engine preservation

Due to the special material of the cylinder wall, there is no need for extra protection against corrosion. At extreme climatic conditions and for long out of service periods we recommend the following to protect the valve guides against corrosion:

- Let engine run until warm, then change oil.
- Remove the air intake filters and insert approx. 30 cm^3 (1 fl oz) of corrosion inhibiting oil into the carburetor throat with the engine running at increased idle speed. Shut off engine.
- Drain carburetor float chamber.
- Apply oil to all joints on carburetors.
- Close **all** openings on the cold engine, such as exhaust end pipe, venting tube, air filter etc. against entry of dirt and humidity.
- Spray all steel external engine parts with corrosion inhibiting oil.

Engine back to operation

- Remove all plugs and fasteners.
- Clean spark plugs with plastic brush and solvent.
- If preservation including oil change took place within a year of storage, oil renewal will not be necessary. For longer storage periods repeat preservation annually.

NOTES

12) Trouble shooting

▲ **WARNING: Only qualified staff (authorized by the Aviation Authorities) trained on this particular engine, is allowed to carry out maintenance and repair work.**

If the following hints regarding remedy do not solve the problem, contact an authorized workshop. The engine must not be operated until the problem is rectified.

Engine does not start

	POSSIBLE CAUSE:	REMEDY:
a -	ignition off	switch on.
b -	closed fuel tap or clogged filter	open tap, clean or renew filter, check fuel system for leaks.
c -	no fuel in tank	refuel.
d -	starting speed too low, faulty or discharged battery	fit fully charged battery.
e -	starting speed too low, start problems on cold engine	use top quality, low friction oil; allow for sufficient cooling period to counter for performance drop on hot starter; pre-heat engine.

Engine idles rough after warm-up period, smoky exhaust emission

	POSSIBLE CAUSE:	REMEDY:
a -	starting carb activated	close starting carb.

Low oil pressure

	POSSIBLE CAUSE:	REMEDY:
a -	not enough oil in oil tank	check oil return line for free passage, renew oil seal.

Engine keeps running with ignition off

	POSSIBLE CAUSE:	REMEDY:
a -	overheating of engine	let engine cool down at idling at approx. 2000 r.p.m.

Oil level is increasing

	POSSIBLE CAUSE:	REMEDY:
a -	oil too cold during engine operation	cover oil cooler surface, maintain the oil temperature prescribed.

Knocking under load

	POSSIBLE CAUSE:	REMEDY:
a -	Octane rating of fuel too low	use fuel with higher octane rating.

Engine hard to start at low temperature

	POSSIBLE CAUSE:	REMEDY:
a -	starting speed too low	preheat engine.
b -	low charge battery	fit fully charged battery.
c -	high oil pressure	at cold start a pressure reading of up to around 7 bar (102 psi) does not indicate a malfunction.
d -	oil pressure too low after cold start	too much resistance in the oil suction tube at low temperatures. Stop engine and preheat oil. At oil pressure reading too low than 1 bar oils with lower viscosity are to be used. See SI-912-016, current issue.

◆ NOTE: Oil pressure must in the idle operation with an oil temperature of min. 50 °C (120°F) to be measured.

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12.1) Reporting

According to the regulation of JAR / FAR 21.3 the manfacturer shall evaluate field information and report to the authority.In case of any relevant occurrences that may involve malfunction of the engine, the form on the next page should be filled out and sent to the responsible authorized ROTAX distributor.

◆ NOTE: The form is also available from the official ROTAX AIRCRAFT ENGINES Homepage

www.rotax-aircraft-engines.com

in electronic version.

ROTAX
AIRCRAFT ENGINES

CUSTOMER SERVICE INFORMATION REPORT

OPER. Control No.	
ATA Code	
1. A/C Reg. No.	

Enter pertinent data	MANUFACTURER	MODEL/SERIES	SERIAL NUMBER
2. AIRCRAFT			
3. POWERPLANT	ROTAX		
4. PROPELLER			

5. SPECIFIC PART *(of component)* CAUSING TROUBLE

Part Name	MFG. Model or Part No.	Serial No.	Part/Defect Location

6. ENGINE COMPONENT *(Assembly that includes part)*

Engine/Comp. Name	Manufacturer	Model or Part No.	Serial Number

Engine TSN	Engine TSO	Engine Condition	7. Date Sub.

8. Comments *(Describe the malfunction or defect and the circumstances under which it occurred. State probable cause and recommendations to prevent recurrence.)*

Optional Information:
Check a box below, if this report is related to an aircraft

☐ Accident; Date _____ ☐ Incident; Date _____

DISTRICT OFFICE	OPERATOR DESIGNATOR
OTHER ☐	
COMMUTER ☐	
ACG ☐	
MFG ☐	
AIR TAXI ☐	
MECH ☐	
OPER ☐	
REP. STA ☐	

SUBMITTED BY:

TELEPHONE NUMBER: ( ) _____

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NOTES

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